Project 2 - Part 1

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1. Introduction

Cache organization and associativity.

2. Implementation

Prepare

Environment

- Docker image krlmlr/debian-ssh on Debian 10 (host).
- File `~/simplesim-3v0e.tgz` is downloaded from http://www.simplescalar.com/.
- File `~/lab_cache_1a.cfg` is downloaded from http://www.ecs.umass.edu/ece/koren/architecture/Simplescalar/lab1_cache_1a.cfg.
- File `~/lab_cache_2a.cfg` is downloaded from http://www.ecs.umass.edu/ece/koren/architecture/Simplescalar/lab1_cache_2a.cfg

Script

```
# install
apt-get install tar build-essential

# unzip
tar zxvf simplesim-3v0e.tgz

# move
mv lab_cache_1a.cfg simplesim-3.0/
mv lab_cache_2a.cfg simplesim-3.0/
```

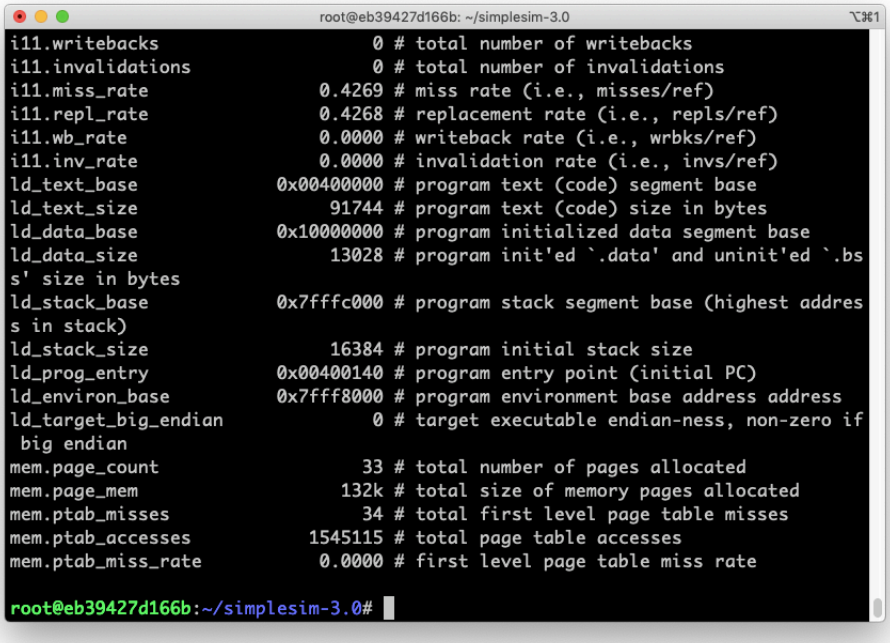
Compile

```
cd ~/simplesim-3.0
make clean
make config-pisa
make
make sim-tests
cd ~
```

Run

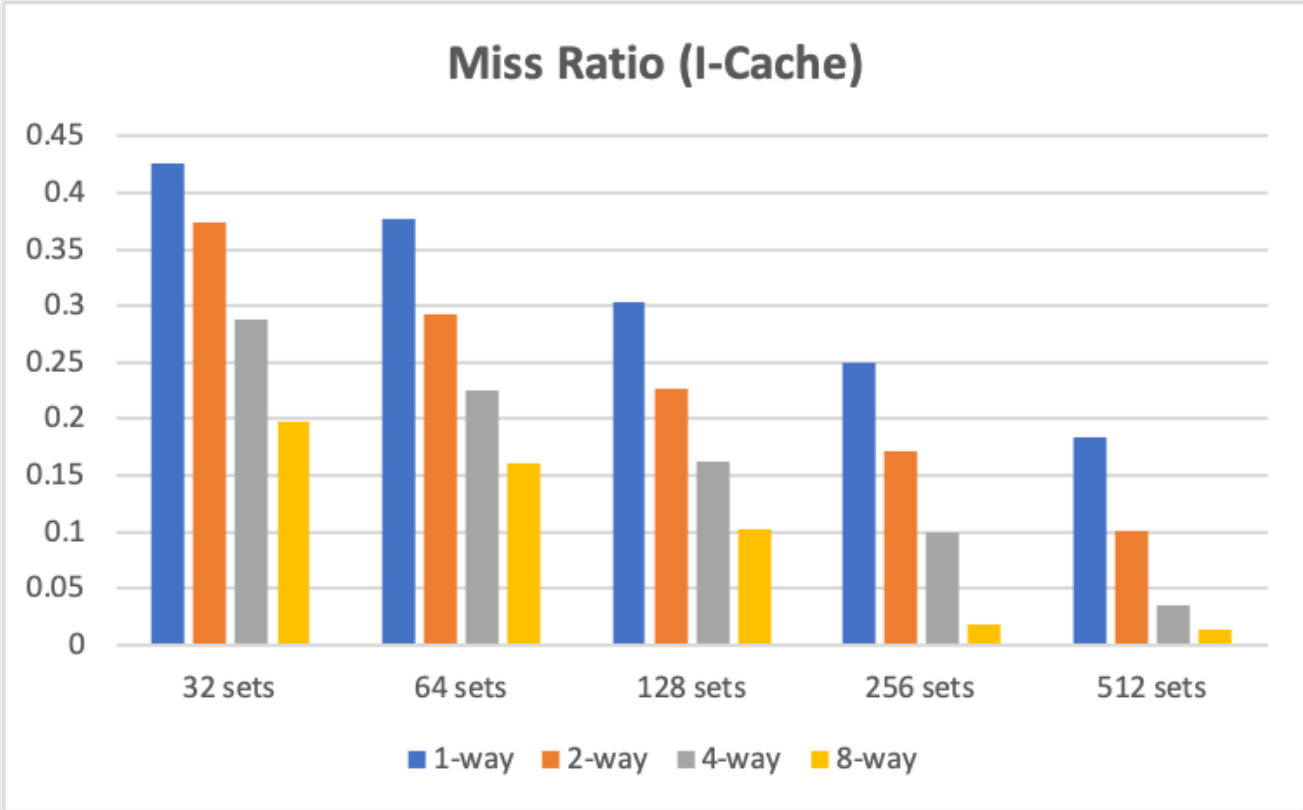
```
cd ./simplesim-3.0/

# change file `lab1_cache_1a.cfg` and run several time
./sim-cache -config lab1_cache_1a.cfg tests-pisa/bin.little/test-math

# change file `lab1_cache_2a.cfg` and run several time
./sim-cache -config lab1_cache_2a.cfg tests-pisa/bin.little/test-math
```

3. Result

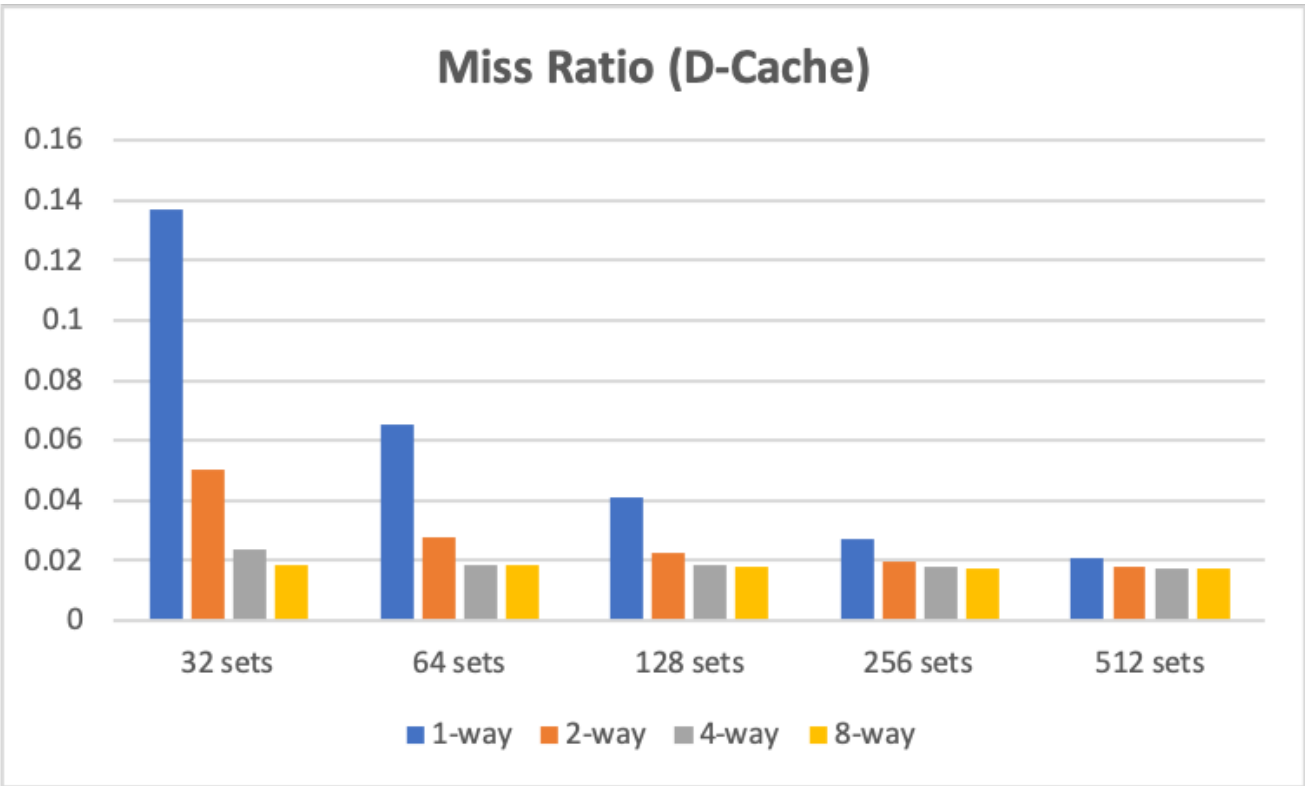


4. Conclusion

Miss Ratio (I-Cache)	1-way	2-way	4-way	8-way
32 sets	0.4269	0.3735	0.2880	0.1983
64 sets	0.3765	0.2921	0.2256	0.1614
128 sets	0.3031	0.2268	0.1619	0.1028
256 sets	0.2504	0.1720	0.0994	0.0176
512 sets	0.1834	0.1010	0.0348	0.0142



Miss Ratio (D-Cache)	1-way	2-way	4-way	8-way
32 sets	0.1372	0.0503	0.0236	0.0185
64 sets	0.0654	0.0280	0.0187	0.0184
128 sets	0.0408	0.0223	0.0184	0.0177
256 sets	0.0273	0.0195	0.0177	0.0176
512 sets	0.0209	0.0179	0.0176	0.0176



5. Discussion

> 1. For a given number of sets, what effect does increasing associativity have on the miss ratio?

The miss ratio will decrease during increasing associativity for fixed number of sets.

> 2. For a given associativity, what is the effect of increasing the number of sets?

The miss ratio will decrease during increasing the number of sets for fixed associativity.

> 3. For a given cache size, how does the miss ratio change when going from an associativity of one to two to four? Explain.

The miss ratio will decrease during increasing associativity for fixed cache size.

> 4. If you were to design a Instruction cache, limited to a total cache size of 4 Kbytes, which cache organization would you choose, based solely on performance?

I would like to choose the organization of "16 bytes - 32 sets - 8 ways".

> 5. If you were to design a data cache, limited to a total cache size of 4 Kbytes, which cache organization would you choose, based solely on performance?

I would like to choose the organization of "16 bytes - 32 sets - 8 ways".